LAKE NABIGAGA

A FIELD SURVEY UNDERTAKEN BY THE NATIONAL FISHERIES RESOURCES RESEARCH INSTITUTE (NaFIRRI)

August 2010

REPORT ON FIELD SURVEY OF LAKE NABIGAGA

1.0 Background

The field survey was undertaken by NaFIRRI technical staff at the request of Rtd. Bishop Cyprian Bamwoze, an up-coming commercial fish farmer in Kamuli District of Eastern Uganda. The terms of reference for the survey were to make an assessment of the lake for possible cage fish farming.

The survey was undertaken on the 26 August 2010 by a team composed of the several technical personnel as shown in the table below:

Name	Specialisation	Institution
1. Mr. Abudala Napuru	Cage fish culture specialist	Source of the Nile (SON) Fish farm
2. Mr. Godfrey Magezi	Physical-chemical parameters and algae specialist	NaFIRRI
3. Mr. Vincent Kiggundu	Micro-invertebrate specialist	NaFIRRI
4. Mr. Pabire Gandhi	Macro-invertebrate specialist	NaFIRRI
5. Ms. J. Naluwairo	Nutrients specialist	NaFIRRI
6. Mr. B. Kamira	Socio-Economic aspects	NaFIRRI
7. Dr. L.M. Ndawula	Aquatic Ecologist/Team Leader	NaFIRRI

2.0 Location

Lake Nabigaga is located in Kamuli District near the Kiige Citrus Scheme (coordinates: 1.2047164N; 33.024645E) and connected by a channel/tributary to the Upper Victoria Nile on its northward flow to Lake Kyoga.

3.0 Key features

The lake is a small shallow water body with a maximum depth of 2 metres. The bottom sediments are mainly soft mud of decomposing plant material occasionally with pellet-like, clumpy clay mixed with silt and plant debris. Upstream towards the Victoria Nile, the shoreline is lined with Water hyacinth, lillies with papyrus in the background. The lake shoreline is indented and is in most areas fringed by swamp. The latter appears to be still intact as there is minimal visible perturbation of the riparian zone by human activities.

4.0 The fishery and other uses of the lake

The lake supports small subsistence fishing activities by the local communities living around it. Information from the local community indicates that the fish species/types occurring in the lake include the Ngege, Nile perch, the African catfish and the lung fish. The fishing crafts in operation are largely Dug-out and Bao Tatu canoes and the main fishing gears are nylon and monofilament gillnets, hooks and beach seines. Besides fishing other uses of the lake and its immediate surroundings include grazing, source of water for domestic use and domestic animals, source of raw materials for making crafts and building, cultivation and a number of cultural practices. A number of these activities may be considered harmful to the lake environment and its fisheries.

5.0 Algal community

Four broad algal groups were recorded namely: Bluegreen algae or Cyanobacteria, Diatoms, Green algae and Cryptophytes.

Low algal species diversity or types was a common feature in the samples collected from the lake. The blue green algae/Cyanobacteria were the dominant group (Fig. 1) with two species *Planktolyngbya* and *Aphanocapsa* as the more common types while the diatom community was represented by *Aulocoseira* and *Nitszchia* types. Algal biomass in form of chlorophyll a did not vary significantly (9.3-11.12 µg/litre) at the three sampled points but was well below the range (i.e. 50-200 µg/litre) in productive aquaculture ponds. The lake's algal community is the primary source of nutrition for fish and other aquatic organisms and the observed types together with detrital particles from dead decomposing organic matter are considered to be the main providers of nutritional needs of the fishes and other water-based organisms.

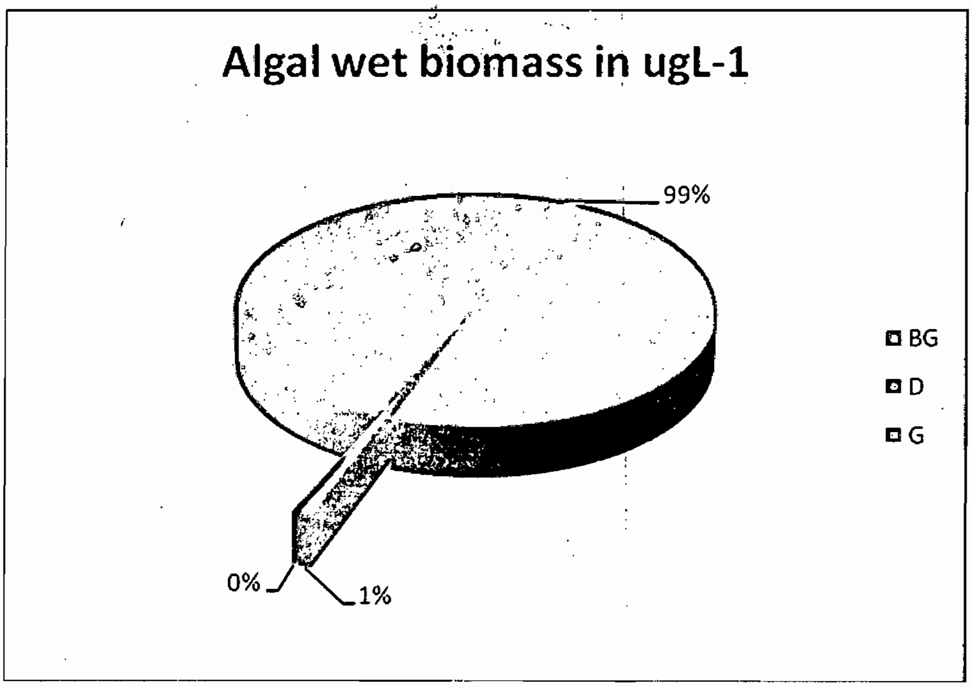

Fig. 1. Relative abundance of algae in Lake Nabigaga, August 2010.
BG = Bluegreen algae; D = Diatoms; G = Green algae

Nutrient status

Dissolved inorganic substances were determined in form of concentrations of selected nitrogen and phosphorus species. Nitrite (NO_2) ranged between 12 and 18.2 µg/litre; NH_4

was between 60.2 and 114 µg/litre while total suspended solids (TSS) was between 77 and 111.3 µg/litre.

6.0 Dissolved oxygen conditions

Relatively high dissolved oxygen concentrations with a mean value of 8.5 mg/L were encountered at all sites visited (Table 1). This observation was most likely due to high photosynthetic activity, which was however not determined during the quick survey. The range of dissolved oxygen (6.2-10.7 mg/L) observed during the survey is considered sufficient to support fish and other aquatic organisms.

7.0 Conductivity

This measure of dissolved solids (244-262 µs/cm) in the water (Table 1) was higher than the level in Lake Victoria (90-120 µs /cm) and comparable to the eastern part of Lake Kyoga (100-300 µs/cm) and was within range suitable for fish productivity.

8.0 Light conditions

The lake water was generally transparent with light penetration up to the bottom sediments. This was possible due to the low algal biomass coupled with the shallow water depth (maximum of 2 metres).

Table 1. Ranges of selected water environment parameters for Lake Nabigaga, August 2010

	Environmental parameters				
	Cond. (µs/cm)	**DO (mg/l)**	**Temp. (°C)**	**pH**	**Secchi depth (m)**
Min	244.0	6.24	26.20	7.49	0.62
Max	289.0	10.67	30.10	9.23	0.85
Mean	262.33	8.51	27.53	8.55	0.74
Std	21.13	1.98	1.40	0.78	0.12

9.0 Alkalinity/acidity (pH) and water temperature conditions

The pH (7.49-9.23) and temperature (26.2-30.1^{0}C) measurements for Lake Nabigaga (Table 1) were within range of what has been observed in Lakes Kyoga and Victoria and are considered suitable for supporting fisheries.

10.0 Micro-invertebrate or zooplankton community

These small-bodied organisms (up to 1.5 mm body length) were sampled along two transects each with 3 sampling points, thus giving a total of 6 sampling sites.

Table 2. Zooplankton of Lake Nabigaga, August 2010: Composition and abundance (No./m^2).

Zooplankton Types:	Transect 1			Transect 2		
	1A	**1B**	**1C**	**2A**	**2B**	**2C**
Copepoda	196,704	310,487	351,550	257,156	220,820	152,991
Cladocera	0	250	4,494	999	333	333
Rotifera	84,122	6,408	67,918	15,562	11,983	37,199
Total	280,826	317,145	423,961	273,717	233,136	190,522

10.1 Composition

The community was made up of three broad taxonomic groups, namely Copepoda, Cladocera (water fleas) and Rotifera (wheel animacules) (Table 2). Copepods and cladocerans can be grouped under a single group, Crustacea. The two are relatively large organisms up to 1 mm body length. Copepods of Lake Nabigaga were constituted by five species/ types, namely *Mesocyclops* sp., *Thermocyclops* sp., *Tropocyclops confinnis*, *Tropocyclops tenellus* and *Thermodiaptomus* sp. Included in this group are two immature stages of copepods, namely nauplius larvae and copepodites at different stages of body development. Cladocera was constituted by two species/types, namely *Moina micrura* and *Diaphanosoma excisum*. The Rotifera contained the highest number (13) of species/types.

10.2 Spatial Distribution

Most of the different types of zooplankton appeared to be widely distributed, being recovered at most of the six sampling sites. The exceptions to this trend were *Mesocyclops* sp (Copepoda); *Euclanis* sp. and *Asplanchna* sp. (Rotifera) which were recovered at a single site each.

10.3 Numerical abundance

Wide variation in numerical abundance of organisms between sites and between the broad categories was a characteristic feature of the community.Total organism densities between sites varied from 190,522 to 423,961 organisms per square metre (Table 2). The bulk of this density (70-90%) was contributed by Copepoda followed by Rotifera and Cladocera respectively. The most numerous types (up to 200, 000 organisms per square metre) were copepodites and nauplius larvae both belonging to the group Copepoda.

11.0 Macro-invertebrate/macro-benthos community

These are larger organisms (over 1.5 mm) that are visible with un-aided eye and occur either on the bottom sediment surface or burrow in the sediments. They were sampled at 3 random sites in the lake at a depth range between 1.6 and 2.3 metres. Three samples were taken at each of the three sites to make a total of nine samples in all.

11.1 Composition

Three classes of macro-benthos were recovered, namely Gastropoda (water-based snails), Insecta (water-based insects) and Oligochaeta (water-based worms) (Table 3). The snails were made up of two species/types ,namely *Bellamya unicolor* and *Melanoides tuberculata*. On the other hand Diptera (True fly larvae) was represented by a diverse range (6) of organisms which included *Chironomus* sp., *Procladius* sp., *Tanypus* sp., *Tanytarsus* sp., *Chaoborus* sp. and *Palpomymia* sp. Oligochaeta was represented by the family Naididae.

11.2 Spatial Distribution patterns

Three dipteran species/types, namely *Chironomus* sp., *Chaoborus* sp., *Tanypus* sp., and the oligochaete, Naididae exhibited wide spatial distribution, being recovered at each of the three stations/sites sampled in the lake. On the other hand, the two mollusc representatives, *Bellamya unicolor* and *Melanoides tuberculata* were rare, having been recovered at a single site (Table 3).

11.3 Numerical abundance

The midge larvae, *Chaoborus* sp. was the most abundant organism with over 500 individuals per square metre of sediment at two of the three sampled sites (Table 3). Naididae was more abundant (140 individuals per square metre) at Station/Point 1 while *Tanypus* sp. was similary more abundant (126 individuals per square metre) at Station/Point 2. Both mollusc representatives (*Bellamya unicolor* and *Melanoides tuberculata)* registered rather low numbers (14 and 42 individuals per square metre) at the single site (Station/Point 1) where they occurred.

Table 3. Macro-benthos of Lake Nabigaga, August 2010: Composition and abundance (No./ m^2).

	Site 1 (1.6 m)	**Site 2 (2.0 m)**	**Site 3 (2.3 m)**	**Mean Total /m^2**
	Sediment texture			
Macro-benthos types:	Pellet-like/clumpy clay with silt and plant debris	Soft bottom of decomposing plant material	Soft bottom with decomposing plant material	
MOLLUSCA				
Bellamya unicolor	14	0	0	5
Melanoides tuberculata	42	0	0	14
DIPTERA				
Chironomus spp.	42	28	14	28
Procladius sp.	14	14	0	9
Tanypus sp.	14	126	14	51
Tanytarsus sp.	0	14	0	5

Chaoborus sp.	42	574	532	383
Palpomyia sp.	0	14	0	5
NAIDIDAE	140	42	14	65

12.0 Discussion of results

Lake Nabigaga may be categorised as a small shallow (productive) tropical lake system in a rural setting. Preliminary visual inspection and assessment afforded by the one-day survey, gives the impression of a pristine environment with minimum perturbations within the lake itself and its immediate surroundings.

The water environment characteristics observed during the survey point to relatively oligotrophic conditions characterised by low algal diversity and biomass and high water transparency. A determination of nutrient levels especially in terms of phosphorus and nitrogen content indicated generally safe levels for fish productivity. Similarly, the data collected and observations made on the various physical-chemical parameters i.e. dissolved oxygen, temperature, conductivity, pH and water transparency all indicate environmental conditions that are comparable to those in Lakes Victoria and Kyoga and are considered normal and suitable to support aquatic life and fish production. Although the algal community of the lake is of low species diversity and is dominated by bluegreen algae, it is devoid of species that are known to be toxic to aquatic organisms and most of the recorded groups are suitable food sources for aquatic organisms including invertebrates and fish. Fishing activities by local communities appear to be at subsistence level largely for nutrional needs of the local people.

The invertebrate community is dominated by groups such as copepods and dipteran (lake fly) larvae that have been found to be ecologically important in other water bodies especially Lakes Victoria and Kyoga. The high abundance values for the small-sized nauplius larvae and the high species diversity of rotifers (Table 2) are an added advantage for growth support of fish larvae irrespective of species; an important attribute in fish recruitment processes. Both copepods and diteran larvae constitute key fish food organisms for a wide rage of fishes of which some are reported to occur in Lake Nabigaga. The distribution and abundance patterns of invertebrate organisms observed and reported here (Tables 2 & 3) are considered favourable and adequate for supporting fishes that depend on them.

13.0 Assessment of the lake for fish production

Overall, the sum-total of the environment of Lake Nabigaga i.e. physical,chemical biological characteristics and nutrient status can be summarised as being suitable for fish production in terms of both capture fisheries and cage fish culture. Three aspects, however, need further examination. The lake maximum depth of just over 2 metres could represent a limiting factor for cage farming due to the requirement of at least 1 metre between the the lake sediments and the bottom of the cage. This provision allows for sufficient water movement to flush away any debris or wastes from rearing the cages; an important safeguad against environmental degradation. This condition is more pertinent in the case of Lake Nabigaga, a small shallow lake that is particularly vulnerable to environment degradation. Secondly, it is equally important to examine and identify all the inflows and outflows of the lake with a view of assessing the flushing rate of the lake as part of the key features that need to be considered for cage farming. A socio-economic survey and analysis involving the local communities and their leadership is also essential as a baseline community barometer prior to embarking on cage culture enterprise on the lake. Preliminary community views on the possibility of introducing an alternative economic activity (cage fish culture) on the lake varied. About 44% of the respondents suggested gazetting such an area while ensuring that their use of the lake remained unhamperes whereas the same proportion insissted on having a general village assembly to take a collective decision. Six (6) percent of respondents welcomed the idea while at the same time expressing caution.